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EXAMINATION OF 1968, TWENTY-FIVE-CENT NICKEL COINS

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

Examination of 1968, twenty-five-cent nickel coins made from material supplied by Sherritt Gordon Mines Limited and the International Nickel Company showed that they contained less than 10% cold work and that their average weights were 5.05 g and 5.01 g respectively, with a mean deviation not greater than 1%.

The coins made from material supplied by Sherritt Gordon Mines Limited had an ASTM grain size of 5 and a Rockwell F hardness range of 63.0 to 80.7 as compared to corresponding values of 7 and 83.2 to 94.3 for coins made from International Nickel Company material.

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INTRODUCTION

For the information of the Royal Canadian Mint, an investigation was carried out to examine the magnetic property, weight, hardness and microstructure of 1968, twenty-five-cent nickel coins made from powder-rolled full-density nickel strip supplied by Sherritt Gordon Mines Limited and those made from cast-billet, hot-rolled nickel strip supplied by the International Nickel Company.

PROCEDURE

Material

The Royal Canadian Mint supplied two lots of 12, uncirculated, 25-cent nickel coins minted in 1968. Twelve coins were made from nickel strip prepared by powder rolling supplied by Sherritt Gordon (Lot A) and 12 were made from hot-rolled nickel strip supplied by International Nickel (Lot B). To identify the coins, they were numbered from 1 to 12 in each lot.

Magnetic Property

The magnetic property of the coins was determined by a Magnegage (American Instrument Company) which measures, on a graduated dial, the attraction of a small permanent magnet to the material being tested. The test yields relative magnetic susceptibility on an arbitrary scale.

Weight

The weights of the coins were determined by weighing on an analytical balance having a sensitivity to 0.1 mg.

Hardness

Three methods were used to determine the hardness of the coins:

1. The superficial hardness of the surface of the coins was determined on a Leitz Miniload hardness tester using a diamond pyramid indentor and a 300-g load. Hardness readings were taken on the flat and raised areas on both sides of the coins numbering from 1 to 8 in both sets.

2. Superficial hardness tests were also made on the cross section of numbers1 and 7 coins of Lot A and 1 and 8 coins of Lot B. The coins were cut in half, then a cross section from each coin was polished and etched. Three rows of hardness measurements were taken at right angles to the surface, one in the centre and one at each end. A row of hardness measurements were also taken along the centre of the coins parallel to the sides.

3. Rockwell F hardness readings were taken at five positions on the flat areas on the obverse side of all coins. Locations of the hardness measurements are shown on the photographed coin in Figure 1. Attempts were made to obtain Rockwell B hardnesses but inconsistent readings dictated the use of the lighter load used for Rockwell F tests.

Metallography

For superficial hardness determinations, a cross section of the two coins from each set were rough-polished on silicon carbide abrasive paper to a 600 grit, then with 9-micron diamond paste on "Metron A" cloth and with 3-micron and 1/4-micron diamond paste on "Metron B" cloth. For final polishing, a suspension of magnesium oxide in water was used on an "Astromet" cloth. After each stage of polishing, in order to remove any flowed metal, the specimens were etched for 10 seconds in a solution of 50 parts glacial acetic acid and 50 parts nitric acid. The final etch was for 2 to 3 seconds.

For metallographic examination, a second cross section at right angles to the above was also polished.

RESULTS AND DISCUSSION

Magnetic Property

The results of the Magnegage readings are shown in Table 1.

From previous work on 0.051-inch (thickness of 25-cent coins) nickel strip supplied by Sherritt Gordon it was established that Magnegage readings varied with the percentage of cold work in the strip according to the graph in Figure 2. The average values of 100.9 for coins in Lot A and 101.5 for coins in Lot B would indicate that coins in both lots contain less than 10% cold work.

Consistent Magnegage readings could not be obtained for the number 7 coin of Lot A or the number 8 coin of Lot B but no reason for these anomalous behaviours could be determined.

Weight

Table 2 shows that the average weights of the two lots of coins are very close - 5.05 g for those in Lot A and 5.01 g for those in Lot B. On examination of the individual weights, five coins in Lot B (Inco material) weighed less than 5 g, whereas none of the coins in Lot A (Sherritt Gordon material) weighed below 5 g. The range and mean deviation of the weights of the coins in Lot B are twice that of the weights of the coins in Lot A, which indicates that the density or thickness of the nickel strip supplied by Sherritt Gordon is more uniform.

Hardness

From results of the superficial hardness and Rockwell F hardness surveys made on the surface of the coins and listed in Table 3, it would appear that the surface of the coins in Lot B is harder than the surface of the coins in Lot A. This is particularly evident in the Rockwell F hardness measurements as shown by the frequency polygon in Figure 2. From this frequency polygon, which was drawn from a limited number of samples (24), the coins made from material supplied by Sherritt Gordon have Rockwell F hardnesses below $R_F 82$, and those made from material supplied by International Nickel have Rockwell F hardnesses above $R_F 82$. The Rockwell F hardnesses were taken only on the flat areas on the obverse side of the coins (Figure 1) as the variations in contour of the raised areas made it impossible to get consistent readings in these areas and there was little room for measurements on flat areas on the reverse side.

The ranges and mean deviations show that there is little variation in the hardness on the surface of the coins.

The Rockwell F hardnesses for the two lots of material can be compared with the hardnesses of circulated 5-cent nickel coins previously examined [1], as is shown in Tables 4 and 5. (In these tables the Rockwell B hardnesses actually determined on the 5-cent nickel coins have been converted using ASTM E 140 to equivalent Rockwell F hardnesses). The 5-cent coins made from material supplied by Sherritt Gordon had an average hardness of $R_F 77$ and the coins made from pure-nickel rolled strip used before 1962 had an average hardness of $R_F 87$. These hardnesses are consistent with the average hardnesses of $R_F 78.8$ for the Sherritt Gordon material and $R_F 88.2$ for the International Nickel material obtained in this investigation.

The superficial hardness measurements made on the polished and etched cross-sections of the 25-cent coins were not consistent as is shown

in the table of results - Table 6. However, the average of a substantial number of readings (42) show that the coins in Lot B are the hardest. This agrees with the results of hardness readings taken on the surface of the coins (Table 3). Comparison of the superficial hardnesses taken on the cross sections (Table 6) with those taken on the surface (Table 3) shows that the surface is harder in both lots as would be expected due to the coining operation.

The hardnesses of the number 7 coin in Lot A and number 8 in Lot B were compared with those of coin number 1 in each lot in an effort to explain the unsatisfactory Magnegage readings on the number 7 and 8 coins. The hardness on the cross section of number 7 in Lot A was lower than the hardness on the cross section of number 1 in Lot A and the surface hardness of number 7 was the lowest in that lot; however, the hardness on the cross section of number 8 in Lot B was higher than that of number 1 and the surface hardness was below the average but harder than some other coins in Lot B. Therefore, no reason for the inconsistent Magnegage readings on the number 7 and number 8 coins could be related to the hardness results obtained.

Microexamination

Photomicrographs of the microstructure on polished and etched cross sections of number 1 and 7 coins in Lot A and 1 and 8 coins in Lot B are shown in Figures 4 to 7. It is evident that the Sherritt Gordon material shown in Figures 4 and 5 has smaller grains (ASTM Grain Size No. 5) than the International Nickel material (ASTM Grain Size No. 7) shown in Figures 6 and 7. Microexamination of cross sections at right angles to the above showed similar structures within each coin and the microstructure of the coins in each set were similar.

CONCLUSIONS

1. Magnegage readings indicate that the coins made from material supplied by both Sherritt Gordon and International Nickel contain less than 10% coldwork.

2. Weights of all the coins do not vary more than 0.17g.

3. Superficial hardness measurements on the cross section and Rockwell F hardness measurements on the surface of the coins are higher for those made from material supplied by International Nickel. A distinction between the two materials can be made from Rockwell F hardness readings on the surface of the coins.

4. The grains in the microstructure of coins made from the material supplied by Sherritt Gordon have an ASTM grain size of 5 as compared to 7 for coins made from material supplied by International Nickel.

5. Reasons for inconsistent Magnegage readings on two of the coins, one from each set is now known.

REFERENCES

1. C.F. Dixon and N.S. Spence, "Hardness Examination of Canadian 5-cent Nickel Coins" - Physical Metallurgy Division Test Report PM-66-2, Department of Energy, Mines and Resources, Ottawa (1966).

CFD:NSS:lc

TABLE 1

Magnegage Readings for 1968, Uncirculated 25-Cent Coins

Coin No.	Sherritt Gordon Mines Limited (Lot A)	International Nickel Co. (Lot B)
1	101	101
2	101	102
3	101	101
4	101	101
5	102	102
6	100	101
7	-	101
8	102	-
9	100	102
10	100	102
11	101	102
12	101	102
Average	100.9	101.5

All values are an average of 12 readings.

TABLE 2

Weight in Grams of 1968, Uncirculated, Nickel 25-Cent Coins

Coin No.	Sherritt Gordon Mines Limited (Lot A)	International Nickel Co. (Lot B)
1	5.0798	5.0127
2	5.0287	4.9315
3	5.0385	5.0359
4	5.0555	5.0560
5	5.0703	4.9380
6	5.0368	5.0282
7	5.0166	4.9649
8	5.0492	4.9472
9	5.0983	5.1016
10	5.0557	5.0504
11	5.0194	5.0811
12	5.0433	4.9853
Average	5.05	5.01
Range	0.08 = 1.6%	0.17 = 3.4%
Mean Deviation	0.02 = 0.4%	0.05 = 1%

TABLE 3

Surface Hardness of 1968, Uncirculated 25-Cent Coins

Coin No.	Sherritt Gordon Mines Limited (Lot A)		International Nickel Co. (Lot B)	
	Superficial DPH*	Rockwell F Hardness**	Superficial DPH*	Rockwell F Hardness**
1	155.1	77.4	157.5	88.2
2	159.9	80.7	156.0	83.2
3	155.5	77.7	158.8	94.3
4	156.3	80.2	157.9	89.2
5	159.5	78.0	150.6	83.3
6	151.2	76.0	153.6	89.3
7	149.1	63.0	160.0	88.0
8	155.7	80.0	154.1	84.0
9		77.2		88.7
10		75.5		93.0
11		80.0		90.8
12		78.8		86.0
Average	155.3	78.8	156.0	88.2
Range	10.8 = 7.6%	5.5 = 7%	9.4= 6%	11.1=12.6%
Mean Deviation	2.6 = 1.7%	1.6 = 2.0%	2.5=1.6%	2.9= 3.3%

* Average of 4 readings.
** Average of 5 readings.

TABLE 4

Hardness of Circulated 5-Cent Coins
(Material Supplied by Sherritt Gordon Mines Limited)

Year	Rockwell B	Rockwell F
1965	34	75.5
1965	34	75.5
1964	36	76.5
1964	45	81.5

Average Rockwell F 77.1.

TABLE 5

Hardness of Circulated 5-Cent Coins
(Pure-Nickel Rolled Strip)

Year	Rockwell B	Rockwell F
1956	50	84.5
1961	58	89.0
1956	53	86.5
1941	55	87.5

Average Rockwell F 87.

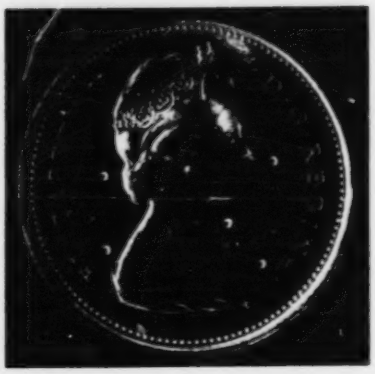
TABLE 6

Superficial (DPH) Hardnesses on Cross Section of 1968, Uncirculated 25-Cent Nickel Coins

	Location of Hardnesses on Coins					
Coins	Center*	Ends**	Parellel to Sides***	Average	Range	Mean Deviation
S.G. No. 1	127	134	130	130	43(33%)	8(6%)
S.G. No. 7	119	138	122	126	36(29%)	10(8%)
INCO No. 1	147	144	134	142	48(34%)	16(11%)
INCO No. 8	142	151	141	144	53(39%)	9(6%)

* Average of 12.
** Average of 12.
*** Average of 18.

S.G. - Sherritt Gordon Mines Limited.
INCO - International Nickel Company.



X2

Figure 1. Showing Position of Rockwell F Hardness Tests.

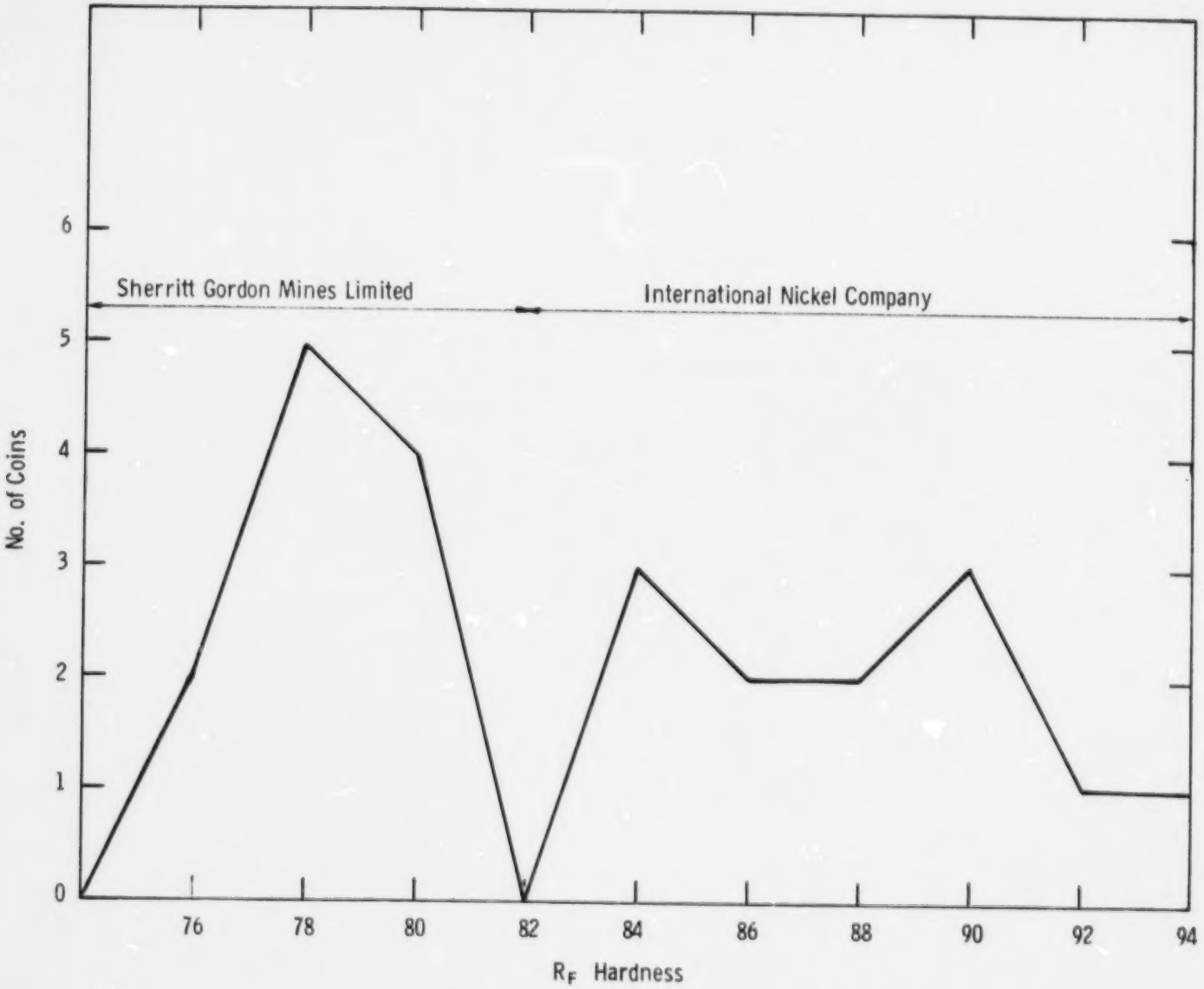


Figure 2 Frequency Polygon - R_F Hardness of 1968, Nickel 25-Cent Coins VS Class Frequency

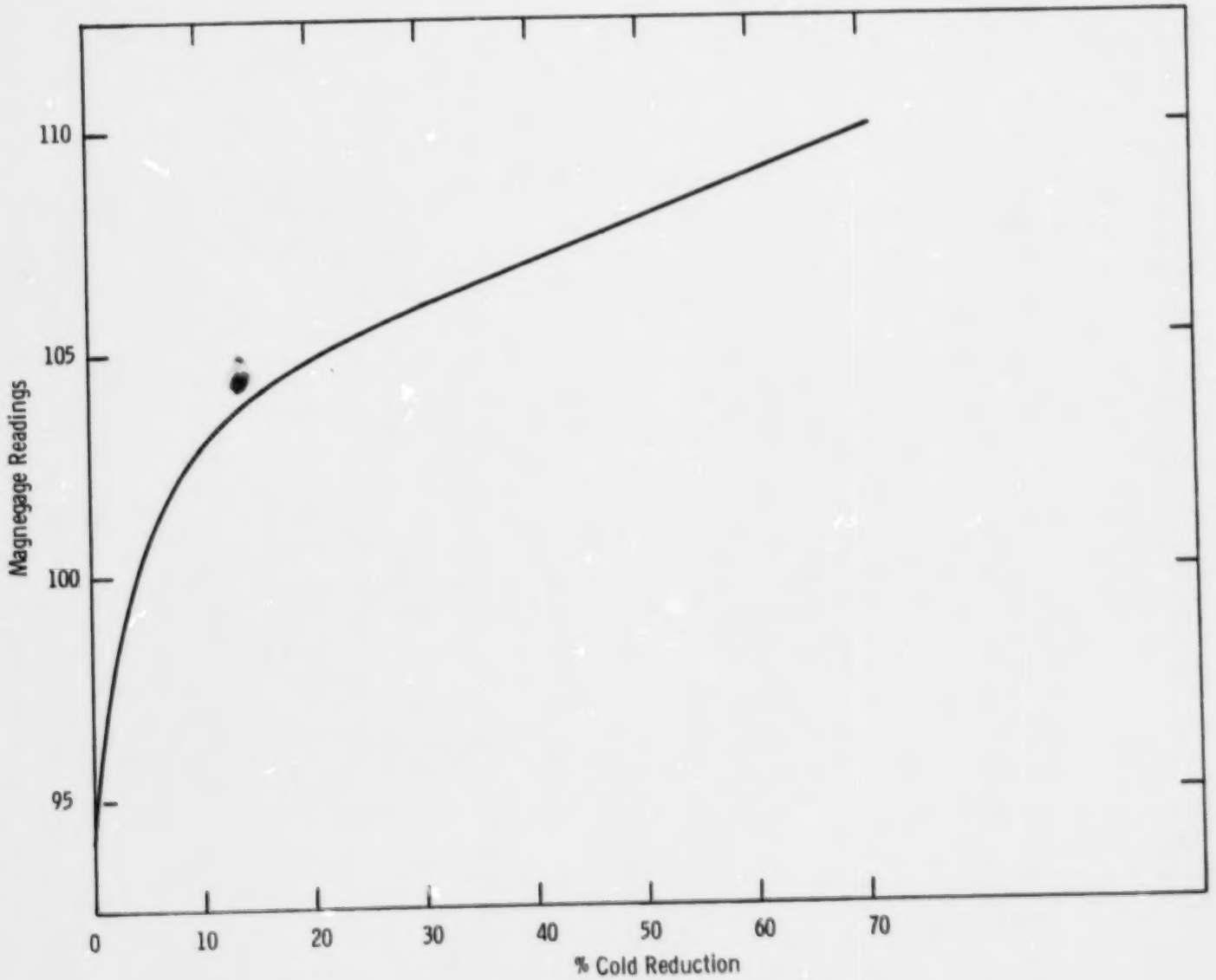


Figure 3 Sherritt Gordon 0.051-In. Nickel Strip - Magnegage Reading VS Per cent Cold Reduction

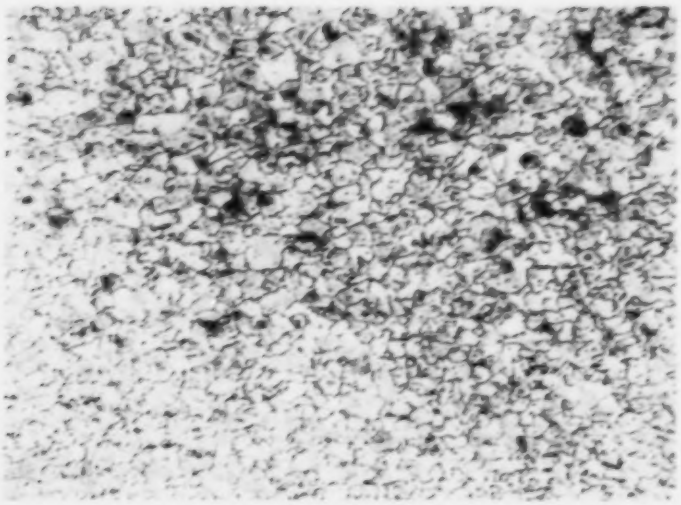


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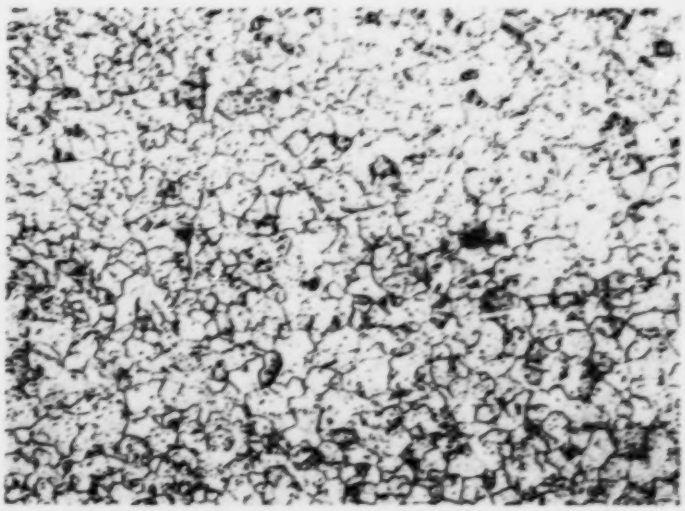
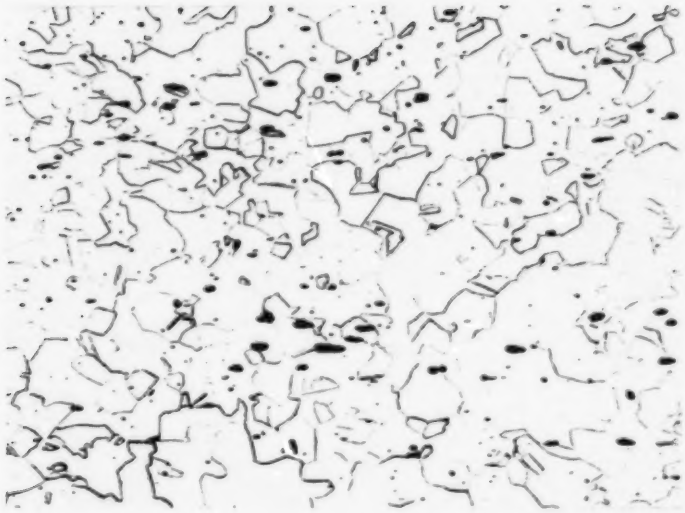
Figure 4. Sherritt Gordon Mines Limited (No. 1)
ASTM Grain Size No. 7.



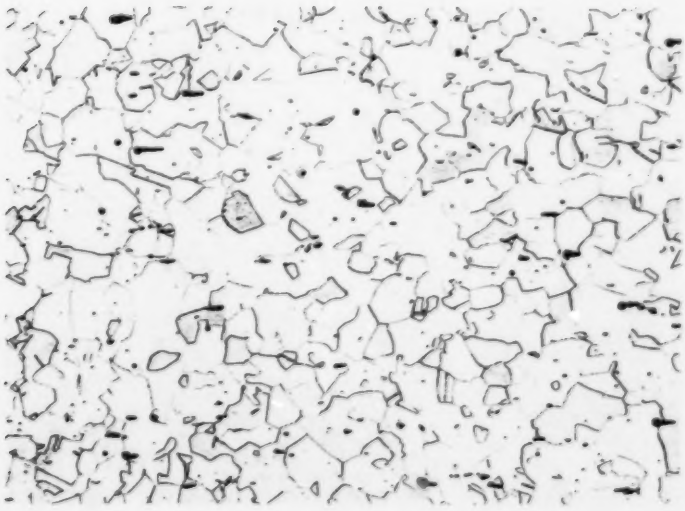
Etched, X100

Figure 5. Sherritt Gordon Mines Limited (No. 7)
ASTM Grain Size No. 7.



Etched, X100

Figure 6. International Nickel Company (No. 1)
ASTM Grain Size No. 5.



Etched, X100

Figure 7. International Nickel Company (No. 8)
ASTM Grain Size No. 5.